

What is claimed is:

1. A wireless transmission system comprising:
a first wireless device including:
5 a first receiver that receives at least one forward path radio frequency (RF) signal, and
 a first transmitter for transmitting a plurality of reverse path RF signals having different carrier frequencies, wherein the reverse path RF signals are phase coherent with the at least one forward path RF signal; and
10 a second wireless device including:
 a second transmitter that transmits the at least one the forward path RF signal received by said first receiver of the first wireless device,
 a second receiver that receives the reverse path RF signals,
 a detector that generates amplitude and phase comparison data based on at least the received reverse path RF signal, and
 a controller/processor that generates transmission path data using the detected amplitude and phase data and the carrier frequencies and identifies from the transmission path data time delay information for RF signals traveling in a direct path between the first and second wireless devices.
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2. The wireless transmission system according to claim 1, wherein said first wireless device further includes a first synthesizer that generates said plurality of reverse path RF signals from the at least one forward path RF signal, each of said plurality of reverse path RF signal being phase coherent with the at least one forward path RF signal.
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3. The wireless transmission system according to claim 1, wherein said detector comprises a phase detector that generates quadrature amplitude and phase data.

4. The wireless transmission system according to claim 1, wherein the at least one forward path RF signal and the reverse paths RF signals are full duplex transmissions.

5. The wireless transmission system according to claim 1, wherein the at least 5 one forward path RF signal and the reverse paths RF signals are half duplex transmissions.

6. The wireless transmission system according to claim 1, wherein the at least one forward path RF signal comprises a plurality of forward path RF signals, the plurality of forward path RF signals comprising a plurality of different carrier frequencies 10 modulated with a modulation signal, the different carrier frequencies having approximately the same multipath transmission characteristics between the first and second wireless devices.

7. The wireless transmission system according to claim 6, wherein the first 15 wireless device further comprises a demodulator for detecting the modulation signal in said plurality of forward path RF signals and a synthesizer for generating said plurality of reverse path RF signals from the modulation signal.

8. The wireless transmission system according to claim 1, wherein the at least 20 one forward path RF signal comprises a carrier signal.

9. The wireless transmission system according to claim 1, wherein the at least one forward path RF signal comprises a modulation signal modulated on at least one carrier signal.

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10. The wireless transmission system according to claim 9, wherein said second wireless device further comprises a synthesizer for generating a plurality of third RF signals that are phase coherent with the modulation signal, wherein said detector includes a phase comparator for phase comparing the plurality of third RF signals and the plurality of 30 reverse path RF signals.

11. The wireless transmission system according to claim 1, wherein said second wireless device further comprises a synthesizer for generating a plurality of third RF signals that are phase coherent with the at least one forward path RF signal, wherein said detector includes a phase comparator for phase comparing the plurality of third RF signals and the plurality of reverse path RF signals.

12. The wireless transmission system according to claim 1, wherein the controller/processor uses a Fourier transform to generate the transmission path data using the detected amplitude and phase data and the carrier frequencies.

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13. The wireless transmission system according to claim 12, wherein the controller/processor further uses a peak search to identify the time delay information.

TECHNICAL FIELD

14. A wireless communication device comprising:
15 a transmitter that transmits at least one forward path radio frequency (RF)

signal;
a receiver that receives a sequence of reverse path RF signals from a first wireless communication device, wherein the received reverse path RF signals are phase coherent with the at least one forward path RF signal;

20 a detector that generates amplitude and phase data based on the received reverse path RF signals and a signal of the at least one forward path RF signal; and

25 a processor that generates transmission path data using at least the detected amplitude and phase data and identifying from the transmission path data time delay information between the received RF signals traveling in a direct path from the first wireless device and the received RF signals traveling in at least one other path from the first wireless device.

15. The wireless communication device according to claim 14, wherein said detector comprises a phase detector that generates quadrature amplitude and phase data.

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16. The wireless communication device according to claim 14, wherein the at least one forward path RF signal comprises a modulation signal that is modulated on a sequence of different carrier frequencies within a predetermined range.

5 17. The wireless communication device according to claim 16, further comprising a synthesizer for generating a plurality of third RF signals that are phase coherent with the modulation signal, wherein said detector generates said amplitude and phase data using the received reverse path RF signals and the generated third RF signals.

10 18. The wireless communication device according to claim 17, wherein the at least one forward path RF signal is a frequency hopping spread spectrum signal.

15 19. The wireless communication device according to claim 14, wherein the at least one forward path RF signal comprises a carrier frequency, and further comprising a synthesizer for generating a plurality of third RF signals that are phase coherent with the carrier frequency, wherein said detector generates said amplitude and phase data using the received reverse path RF signals and the generated third RF signals.

20 20. The wireless communication device according to claim 14, wherein said transmitter and receiver transmit and receive the at least one forward path RF signal and the reverse paths RF signals in full duplex.

25 21. The wireless communication device according to claim 14, wherein said transmitter and receiver transmit and receive the at least one forward path RF signal and the reverse paths RF signals in half duplex.

22. The wireless communication device according to claim 14, wherein the processor uses a Fourier transform to generate the transmission path data using the detected amplitude and phase data and the carrier frequencies.

23. The wireless communication device according to claim 22, wherein the processor further uses a peak search to identify the time delay information.

24. The wireless communication device according to claim 22, wherein the 5 processor determines the distance between the wireless communication device and the first wireless device based on the time delay information.

25. A wireless communication device comprising:
a transmitter that transmits a forward path signal;
10 a receiver that receives a sequence of reverse path RF signals from a first wireless communication device, wherein the received reverse path RF signals are phase coherent with the forward path signal;
a synthesizer that generates a plurality of local RF signals using the forward path signal;
15 a phase comparator that generates amplitude and phase data based on the received reverse path RF signals and the local RF signals; and
a processor that generates transmission path data using the detected amplitude and phase data and frequency information of the received reverse path RF signals and identifying from the transmission path data time delay information between the 20 received RF signals traveling in a direct path from the first wireless device and the received RF signals traveling in at least one other path from the first wireless device.

26. A wireless communication device comprising:
a transmitter that transmits a forward path signal;
25 a receiver that receives a sequence of reverse path RF signals from a first wireless communication device, wherein the received reverse path RF signals are phase coherent with the forward path signal;
a synthesizer that generates a plurality of local RF signals that are phase coherent with the forward path signal;
30 a detector that generates amplitude and phase data based on the received reverse path RF signals and the local RF signals; and

a processor that calculates a direct path distance between the wireless communication device and the first wireless communication device using the detected amplitude and phase data and frequency information of the received reverse path RF signals.

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27. A wireless communication device comprising:
a transmitter that transmits a forward path signal;
a receiver that receives a sequence of reverse path RF signals from a first wireless communication device, wherein the received reverse path RF signals are phase coherent with the forward path signal;

10 detecting means for detecting amplitude and phase data based on the received reverse path RF signals and at least a portion of the forward path signal; and

15 a processor that calculates a direct path distance between the wireless communication device and the first wireless communication device using the detected amplitude and phase data and frequency information of the received reverse path RF signals.

28. A method of operating a wireless communication device comprising:
generating a forward path signal,
transmitting the forward path signal over a wireless link,
receiving reverse path radio frequency (RF) signals, each of said received RF signals having a different carrier frequency within the frequency range that exhibits substantially the same multipath characteristics and each of said received RF signals having a coherent phase relationship with the forward path signal;
- 20 generating amplitude and phase data using at least the received RF signals and the forward path signal,
storing amplitude and phase data corresponding to each of said received RF signals;
- 25 generating Fast Fourier Transform (FFT) data using said stored amplitude and phase data and said carrier frequencies; and

generating from the FFT data time delay information for received RF signals traveling in a direct path from the first wireless device and received RF signals traveling in at least one other path from the first wireless device.

5 29. The method according to claim 28, wherein the step of generating amplitude and phase data comprises generating local RF signals using the forward path signal and comparing the phase of the local RF signals and the received RF signals.

10 30. A computer readable storage medium containing instructions for controlling a wireless communication device, comprising instructions for:

controlling a synthesizer to generate a forward path signal,
controlling a transmitter to transmit the forward path signal over a wireless link, and

15 calculating transmission path data based on amplitude, phase, and frequency data, the amplitude and phase data derived from received radio frequency (RF) signals, each of said received RF signals having a different carrier frequency within the frequency range that exhibits substantially the same multipath characteristics and each of said received RF signals having a coherent phase relationship with the forward path signal; and
20 calculating time delay data from the transmission path data, the time delay data representing a time delay of RF signals travelling in a direct path between the wireless communication device and a wireless communication device that transmitted the received RF signals.